

## WHAT IS CLAIMED IS:

1. A hydrogel composite comprising an interpenetrating network of a polymer of at least one ethylenically-unsaturated monomer and a multiolefinic crosslinking agent, said polymer being crosslinked to particles of a disintegrant.

2. The hydrogel composite of claim 1, wherein the ratio of crosslinking agent to monomer is in the range of 0.01:100 to 10:100.

3. The hydrogel composite of claim 1, wherein the ratio of disintegrant to polymer is in the range of 1:100 to 100:100.

4. The hydrogel composite of claim 1, wherein the at least one ethylenically-unsaturated monomer is selected from the group consisting of (meth)acrylic acid, salts of (meth)acrylic acid, esters of (meth)acrylic acid, salts and acids of esters of (meth)acrylic acid, amides of (meth)acrylic acid, N-alkyl amides of (meth)acrylic acid, salts and acids of N-alkyl amides of (meth)acrylic acid, N-vinyl pyrrolidinone, acrylamide, acrylamide derivatives, methacrylamide, methacrylamide derivatives, and mixtures thereof.

5. The hydrogel composite of claim 1, wherein the at least one ethylenically-unsaturated monomer is selected from the group consisting of acrylamide (AM), N-isopropylacrylamide (NIPAM), 2-

hydroxyethyl methacrylate (HEMA), 2-hydroxypropyl methacrylate (HPMA), N-vinyl pyrrolidinone (VP), acrylic acid (AA), 2-acrylamido-2-methyl-1-propanesulfonic acid (AMPS), 3-sulfopropyl acrylate, potassium salt (SPAK), 2-(acryloyloxy)ethyltrimethylammonium methyl sulfate (ATMS), inorganic salts thereof, and mixtures thereof.

6. The hydrogel composite of claim 1, wherein the crosslinking agent is selected from the group consisting of (N,N'-methylene-bisacrylamide), ethylene glycol di(meth)acrylate, piperazine diacrylamide, glutaraldehyde, epichlorohydrin, crosslinking agents containing 1,2-diol structures, crosslinking agents containing functionalized peptides, and crosslinking agents containing proteins.

7. The hydrogel composite of claim 1, wherein the particles of disintegrant are selected from the group consisting of crosslinked natural polyelectrolytes, crosslinked synthetic polyelectrolytes, crosslinked neutral, hydrophilic polymers, non-crosslinked forms of said polyelectrolytes and polymers having particulate shapes, and porous, inorganic materials that provide wicking by capillary forces.

8. The hydrogel composite of claim 1, wherein the particles of disintegrant are selected from the group consisting of crosslinked sodium carboxymethylcellulose, crosslinked sodium

starch glycolate, crosslinked sodium carboxymethyl starch, crosslinked dextran sulfate, crosslinked chitosan, crosslinked hyaluronic acid, crosslinked sodium alginate, crosslinked pectinic acid, crosslinked deoxyribonucleic acids, crosslinked ribonucleic acid, crosslinked gelatin, crosslinked albumin, polyacrolein potassium, sodium glycine carbonate, crosslinked poly(acrylic acid), crosslinked poly(styrene sulfonate), crosslinked poly(aspartic acid), crosslinked polylysine, crosslinked polyvinylpyrrolidone, crosslinked ultramylopectin, crosslinked poly(ethylene glycol), crosslinked neutral cellulose derivatives, microcrystalline cellulose, powdered cellulose, cellulose fiber, and crosslinked starch.

9. The hydrogel composite of claim 1 which has a swelling ratio in the range of 2 to 1,000.

10. The hydrogel composite of claim 1 which has a compression modulus in the range of 0.01 to 5 kg/cm<sup>2</sup>.

11. The hydrogel composite of claim 1 which has a swelling time in the range of 10 seconds to 10 hours for a sample having a size in the range of 0.01 cm<sup>3</sup> and larger.

12. A superporous hydrogel composite comprising an interpenetrating network of a polymer of at least one ethylenically-unsaturated monomer and a multiolefinic

crosslinking agent, said polymer being crosslinked to particles of a disintegrant, and having a superporous pore structure.

13. The superporous hydrogel composite of claim 12, wherein the ratio of crosslinking agent to monomer is in the range of 0.01:100 to 10:100.

14. The superporous hydrogel composite of claim 12, wherein the ratio of disintegrant to polymer is in the range of 1:100 to 100:100.

15. The superporous hydrogel composite of claim 12, wherein the at least one ethylenically-unsaturated monomer is selected from the group consisting of (meth)acrylic acid, salts of (meth)acrylic acid, esters of (meth)acrylic acid, salts and acids of esters of (meth)acrylic acid, amides of (meth)acrylic acid, N-alkyl amides of (meth)acrylic acid, salts and acids of N-alkyl amides of (meth)acrylic acid, N-vinyl pyrrolidinone, acrylamide, acrylamide derivatives, methacrylamide, methacrylamide derivatives, and mixtures thereof.

16. The superporous hydrogel composite of claim 12, wherein the at least one ethylenically-unsaturated monomer is selected from the group consisting of acrylamide (AM), N-isopropylacrylamide (NIPAM), 2-hydroxyethyl methacrylate (HEMA), 2-hydroxypropyl methacrylate (HPMA), N-vinyl pyrrolidinone (VP), acrylic acid

(AA), 2-acrylamido-2-methyl-1-propanesulfonic acid (AMPS), 3-sulfopropyl acrylate, potassium salt (SPAK), 2-(acryloyloxy)ethyltrimethyl-ammonium methyl sulfate (ATMS), inorganic salts thereof, and mixtures thereof.

5 17. The superporous hydrogel composite of claim 12, wherein the crosslinking agent is selected from the group consisting of (N,N'-methylene-bisacrylamide), ethylene glycol di(meth)acrylate, piperazine diacrylamide, glutaraldehyde, epichlorohydrin, crosslinking agents containing 1,2-diol structures, crosslinking  
10 agents containing functionalized peptides, and crosslinking agents containing proteins.

18. The superporous hydrogel composite of claim 12, wherein the particles of disintegrant are selected from the group consisting of crosslinked natural polyelectrolytes, crosslinked synthetic polyelectrolytes, crosslinked neutral, hydrophilic polymers, non-  
15 crosslinked forms of said polyelectrolytes and polymers having particulate shapes, and porous, inorganic materials that provide wicking by capillary forces.

19. The hydrogel composite of claim 12, wherein the particles of  
20 disintegrant are selected from the group consisting of crosslinked sodium carboxymethylcellulose, crosslinked sodium starch glycolate, crosslinked sodium carboxymethyl starch, crosslinked dextran sulfate, crosslinked chitosan, crosslinked

hyaluronic acid, crosslinked sodium alginate, crosslinked pectinic acid, crosslinked deoxyribonucleic acids, crosslinked ribonucleic acid, crosslinked gelatin, crosslinked albumin, polyacrolein potassium, sodium glycine carbonate, crosslinked poly(acrylic acid), crosslinked poly(styrene sulfonate), crosslinked poly(aspartic acid), crosslinked polylysine, crosslinked polyvinylpyrrolidone, crosslinked ultramylopectin, crosslinked poly(ethylene glycol), crosslinked neutral cellulose derivatives, microcrystalline cellulose, powdered cellulose, cellulose fiber, and crosslinked starch.

20. The superporous hydrogel composite of claim 12 which has a swelling ratio in the range of 5 to 5000.

21. The superporous hydrogel composite of claim 12 which has a swelling time in the range of 1 second to 1 hour for a sample having a size in the range of 0.01 cm<sup>3</sup> and larger.

22. A superporous hydrogel composite prepared by a process comprising:

combining at least one ethylenically-unsaturated monomer, a multiolefinic crosslinking agent, particles of a disintegrant, and a blowing agent to form an admixture thereof; and

subjecting said admixture to polymerization and foaming conditions, whereby said ethylenically-unsaturated monomer, multiolefinic crosslinking agent, and disintegrant are

crosslinked to form said superporous hydrogel composite.

23. The superporous hydrogel composite of claim 22, which has an average pore size in the range of 10  $\mu\text{m}$  to 3,000  $\mu\text{m}$ .

24. The superporous hydrogel composite of claim 22, which has an average pore size in the range of 50  $\mu\text{m}$  to 1,000  $\mu\text{m}$ .

25. The superporous hydrogel composite of claim 22, which has an average pore size in the range of 100  $\mu\text{m}$  to 600  $\mu\text{m}$ .

26. The superporous hydrogel composite of claim 22, wherein the ratio of crosslinking agent to monomer is in the range of 0.01:100 to 10:100.

27. The superporous hydrogel composite of claim 22, wherein the ratio of disintegrant to polymer is in the range of 1:100 to 100:100.

28. The superporous hydrogel composite of claim 22, wherein the at least one ethylenically-unsaturated monomer is selected from the group consisting of (meth)acrylic acid, salts of (meth)acrylic acid, esters of (meth)acrylic acid, salts and acids of esters of (meth)acrylic acid, amides of (meth)acrylic acid, N-alkyl amides of (meth)acrylic acid, salts and acids of N-alkyl amides of (meth)acrylic acid, N-vinyl pyrrolidinone, acrylamide,

acrylamide derivatives, methacrylamide, methacrylamide derivatives, and mixtures thereof.

29. The superporous hydrogel composite of claim 22, wherein the at least one ethylenically-unsaturated monomer is selected from the group consisting of acrylamide (AM), N-isopropylacrylamide (NIPAM), 2-hydroxyethyl methacrylate (HEMA), 2-hydroxypropyl methacrylate (HPMA), N-vinyl pyrrolidinone (VP), acrylic acid (AA), 2-acrylamido-2-methyl-1-propanesulfonic acid (AMPS), 3-sulfopropyl acrylate, potassium salt (SPAK), 2-(acryloyloxy)ethyltrimethyl-ammonium methyl sulfate (ATMS), inorganic salts thereof, and mixtures thereof.

30. The superporous hydrogel composite of claim 22, wherein the crosslinking agent is selected from the group consisting of (N,N'-methylene-bisacrylamide), ethylene glycol di(meth)acrylate, piperazine diacrylamide, glutaraldehyde, epichlorohydrin, crosslinking agents containing 1,2-diol structures, crosslinking agents containing functionalized peptides, and crosslinking agents containing functionalized proteins.

31. The superporous hydrogel composite of claim 22, wherein the particles of disintegrant are selected from the group consisting of crosslinked natural polyelectrolytes, crosslinked synthetic polyelectrolytes, crosslinked neutral, hydrophilic polymers, non-crosslinked forms of said polyelectrolytes and polymers having



particulate shapes, and porous, inorganic materials that provide wicking by capillary forces.

32. The superporous hydrogel composite of claim 22, wherein the particles of disintegrant are selected from the group consisting of crosslinked sodium carboxymethylcellulose, crosslinked sodium starch glycolate, crosslinked sodium carboxymethyl starch, crosslinked dextran sulfate, crosslinked chitosan, crosslinked hyaluronic acid, crosslinked sodium alginate, crosslinked pectinic acid, crosslinked deoxyribonucleic acids, crosslinked ribonucleic acid, crosslinked gelatin, crosslinked albumin, polyacrolein potassium, sodium glycine carbonate, crosslinked poly(acrylic acid), crosslinked poly(styrene sulfonate), crosslinked poly(aspartic acid), crosslinked polylysine, crosslinked polyvinylpyrrolidone, crosslinked ultramylopectin, crosslinked poly(ethylene glycol), crosslinked neutral cellulose derivatives, microcrystalline cellulose, powdered cellulose, cellulose fiber, and crosslinked starch.

33. The superporous hydrogel composite of claim 22, wherein the blowing agent is  $\text{NaHCO}_3$ ,  $\text{Na}_2\text{CO}_3$ ,  $\text{CaCO}_3$ , or gas bubbles introduced from an external source.

34. The superporous hydrogel composite of claim 22, wherein the swelling ratio is in the range of 5 to 5,000.

35. The superporous hydrogel composite of claim 22, wherein the swelling time is in the range of 1 second to 1 hour.

36. A superporous hydrogel composite produced by drying the superporous hydrogel composite formed in claim 22 by air drying  
5 or by replacing water in the composite with an organic solvent followed by air-drying.

37. The superporous hydrogel of claim 36, which upon drying exhibits elastic properties of compression, extension, and folding without breaking.

38. A superporous hydrogel composite produced by drying the superporous hydrogel composite formed as in claim 22 by freeze-drying after partial swelling or equilibrium swelling in aqueous solution.

39. The superporous hydrogel of claim 38, which upon drying  
15 exhibits elastic properties of compression, extension, and folding without breaking.

40. A method of forming a hydrogel composite comprising:

combining at least one ethylenically-unsaturated monomer, a multiolefinic crosslinking agent, and particles of a  
20 disintegrant, to form an admixture thereof, and

subjecting said admixture to polymerization conditions to

form said hydrogel composite.

41. The method of claim 40, wherein said at least one ethylenically-unsaturated monomer is selected from the group consisting of (meth)acrylic acid, salts of (meth)acrylic acid, esters of (meth)acrylic acid, salts and acids of esters of (meth)acrylic acid, amides of (meth)acrylic acid, N-alkyl amides of (meth)acrylic acid, salts and acids of N-alkyl amides of (meth)acrylic acid, N-vinyl pyrrolidinone, acrylamide, acrylamide derivatives, methacrylamide, methacrylamide derivatives, and mixtures thereof.

42. The method of claim 40, wherein the crosslinking agent is selected from the group consisting of (N,N'-methylene-bisacrylamide), ethylene glycol di(meth)acrylate, piperazine diacrylamide, glutaraldehyde, epichlorohydrin, crosslinking agents containing 1,2-diol structures, crosslinking agents containing functionalized peptides, and crosslinking agents containing functionalized proteins.

43. The method of claim 40, wherein the particles of disintegrant are selected from the group consisting of crosslinked natural polyelectrolytes, crosslinked synthetic polyelectrolytes, crosslinked neutral, hydrophilic polymers, non-crosslinked forms of said polyelectrolytes and polymers having particulate shapes, and porous, inorganic materials that provide wicking by capillary

forces.

44. The method of claim 40, wherein the particles of disintegrant are selected from the group consisting of crosslinked sodium carboxymethylcellulose, crosslinked sodium starch glycolate, crosslinked sodium carboxymethyl starch, crosslinked dextran sulfate, crosslinked chitosan, crosslinked hyaluronic acid, crosslinked sodium alginate, crosslinked pectinic acid, crosslinked deoxyribonucleic acids, crosslinked ribonucleic acid, crosslinked gelatin, crosslinked albumin, polyacrolein potassium, sodium glycine carbonate, crosslinked poly(acrylic acid), crosslinked poly(styrene sulfonate), crosslinked poly(aspartic acid), crosslinked polylysine, crosslinked polyvinylpyrrolidone, crosslinked ultramylopectin, crosslinked poly(ethylene glycol), crosslinked neutral cellulose derivatives, microcrystalline cellulose, powdered cellulose, cellulose fiber, and crosslinked starch.

45. The method of claim 40, further combining water with said admixture prior to subjecting the admixture to said polymerization conditions.

46. The method of claim 40, further combining a polymerization initiator with said admixture prior to subjecting the admixture to said polymerization conditions.

47. A method of forming a superporous hydrogel composite comprising:

combining at least one ethylenically-unsaturated monomer, a multiolefinic crosslinking agent, particles of a disintegrant, and a blowing agent to form an admixture thereof; and

subjecting said admixture to polymerization and foaming conditions to thereby form said superporous hydrogel composite.

48. The method of claim 47, wherein said at least one ethylenically-unsaturated monomer, a multiolefinic crosslinking agent, and particles of a disintegrant are combined prior to combining the blowing agent therewith.

49. The method of claim 47, wherein said at least one ethylenically-unsaturated monomer is selected from the group consisting of (meth)acrylic acid, salts of (meth)acrylic acid, esters of (meth)acrylic acid, salts and acids of esters of (meth)acrylic acid, amides of (meth)acrylic acid, N-alkyl amides of (meth)acrylic acid, salts and acids of N-alkyl amides of (meth)acrylic acid, N-vinyl pyrrolidinone, acrylamide, acrylamide derivatives, methacrylamide, methacrylamide derivatives, and mixtures thereof.

50. The method of claim 47, wherein said crosslinking agent is selected from the group consisting of (N,N'-methylene-bisacrylamide), ethylene glycol di(meth)acrylate, piperazine

diacrylamide, glutaraldehyde, epichlorohydrin, crosslinking agents containing 1,2-diol structures, crosslinking agents containing functionalized peptides, and crosslinking agents containing functionalized proteins.

5 51. The method of claim 47, wherein the particles of disintegrant are selected from the group consisting of crosslinked natural polyelectrolytes, crosslinked synthetic polyelectrolytes, crosslinked neutral, hydrophilic polymers, non-crosslinked forms of said polyelectrolytes and polymers having particulate shapes, and porous, inorganic materials that provide wicking by capillary forces.

52. The method of claim 47, wherein the particles of disintegrant are selected from the group consisting of crosslinked sodium carboxymethylcellulose, crosslinked sodium starch glycolate, crosslinked sodium carboxymethyl starch, crosslinked dextran sulfate, crosslinked chitosan, crosslinked hyaluronic acid, crosslinked sodium alginate, crosslinked pectinic acid, crosslinked deoxyribonucleic acids, crosslinked ribonucleic acid, crosslinked gelatin, crosslinked albumin, polyacrolein potassium, sodium glycine carbonate, crosslinked poly(acrylic acid), crosslinked poly(styrene sulfonate), crosslinked poly(aspartic acid), crosslinked polylysine, crosslinked polyvinylpyrrolidone, crosslinked ultramylopectin, crosslinked poly(ethylene glycol), crosslinked neutral cellulose derivatives, microcrystalline

cellulose, powdered cellulose, cellulose fiber, and crosslinked starch.

53. The method of claim 47, further combining water with said admixture prior to subjecting the admixture to said polymerization and foaming conditions.

54. The method of claim 47, further combining a foam stabilizing agent with said admixture prior to subjecting the admixture to said polymerization and foaming conditions.

55. The method of claim 47, further combining a polymerization initiator with said admixture prior to subjecting the admixture to said polymerization and foaming conditions.